MAG Systems Management and Operations (SMO) Plan

FINAL Task 3 Report – Long Term Vision and Concept of System Management and Operations

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1 INTRODUCTION

This document establishes the long-term vision (2030) and the anticipated regional concept of systems management and operations (SMO) for the MAG region. The vision identifies the desired future state of the regional transportation system in relation to operations and management based on input from the MAG regional partners as well as assumptions on likely future scenarios in the MAG region. The long-term vision looks at a future that leverages existing institutional structures and processes for operations and management of the transportation network.

The 2030 vision and future concept of operations was driven by input from the SMO Technical Advisory Group (TAG) and other transportation system management and operations experts. There were three types of methods used to gather stakeholder input for the 2030 vision. These included:

- *Visioning workshops with the TAG members* – structured format to discuss and brainstorm on what could be implemented as part of a 2030 system in the MAG region;
- *Electronic surveys* – as part of the inventory task, agencies were asked to identify areas that could be improved to better support their operations in terms of training, maintenance, or staffing; and
- *Expert panel evaluation of MAG region opportunities* – leveraging knowledge of industry experts and other metropolitan area SMO strategies and institutional frameworks.

Information from these sources as well as knowledge of local agency priorities, transportation system challenges, and agency relationships were used to develop the 2030 vision with the TAG members.

The vision provides an important roadmap toward the desired level of system management and operations. To achieve the vision, there will need to be enabling policies and expanded partnerships (public and private). The vision will potentially evolve over the course of the SMO Plan as more specific implementation strategies and performance goals are established.

2 2030 VISION AND FUTURE CONCEPT FOR SMO

Figure 1 presents a long-term vision and future concept for SMO in the MAG region.

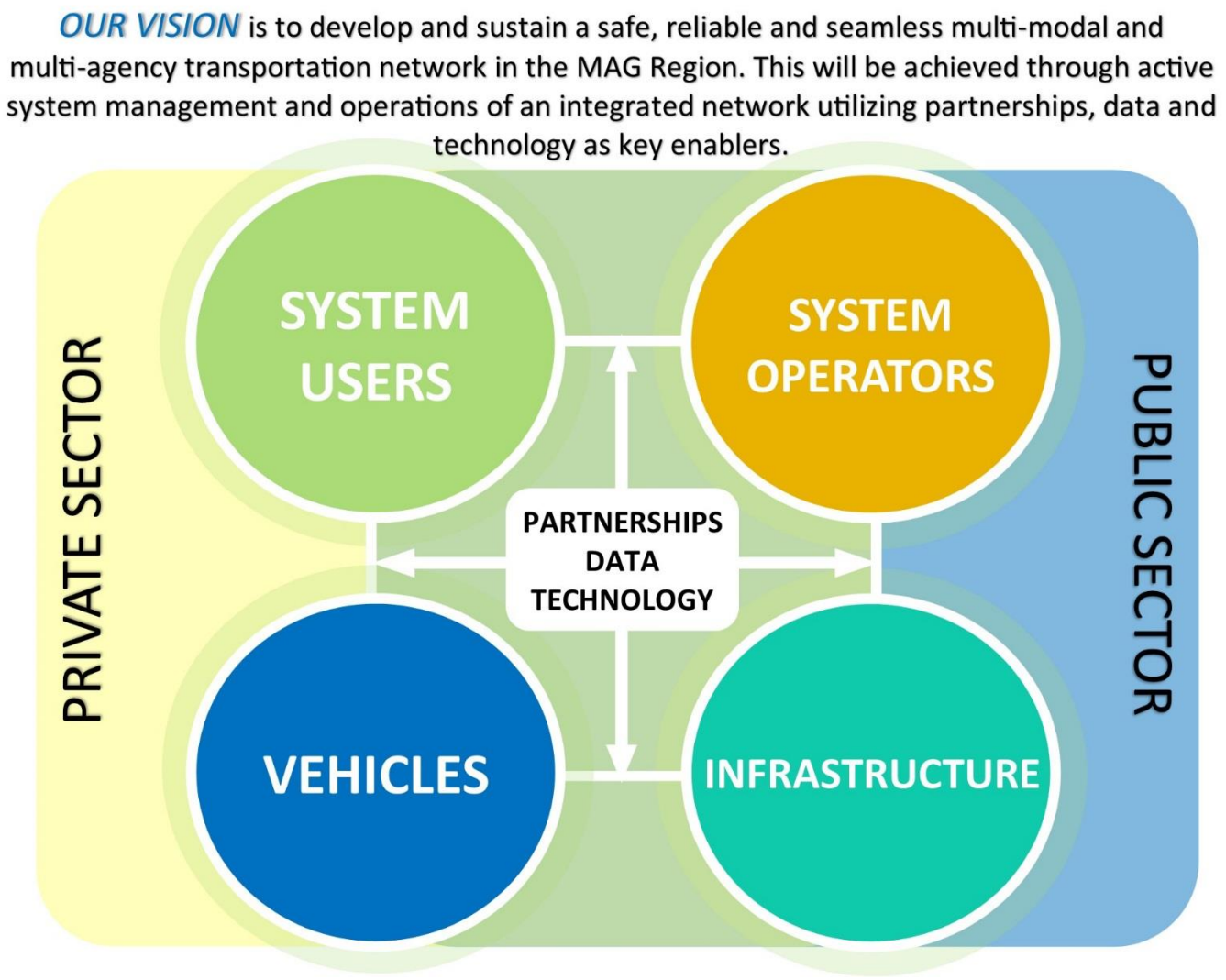

Figure 1 – 2030 Vision and Concept for MAG Regional SMO

There are four key components of SMO in the future vision and concept:

- **System Users** – those who interact with the various components of the regional transportation system, including travelers, transit riders, commercial vehicle drivers, bicyclists and pedestrians;
- **System Operators** – entities or agencies that own, manage and operate the infrastructure and systems that make up the regional transportation system;
- **Vehicles** – vehicles that use the transportation system, including cars, trucks, buses, and other modes of travel in the region; and
- **Infrastructure** – facilities and systems that make up the regional transportation network, including field devices, communications infrastructure and operating centers.

There are three important aspects of systems management and operation that provide an essential link among the core components: **Partnerships**, **Data** and **Technology**.

The MAG region recognizes that the future regional system management and operations strategy will include both the public and private sectors, and will rely on partnerships among and between the two. **Public sector** agencies are largely responsible for system operation and infrastructure maintenance for the regional network. They also influence the system users and vehicles that use the network. The public sector responsibilities are supported through partnerships with other entities, the use of relevant and emerging technology, and the generation and utilization of data to support operations and maintenance.

There is an increasing need for the public sector to interact with the **private sector** for system management and operations activities. The private sector has assumed a role where they have significant influence on the system users and vehicles on the regional network through outlets such as traveler information (i.e. Waze, Google), autonomous vehicle technology (i.e. Google, auto manufacturers) and the concept of mobility as a service (including providers such as Uber and Lyft). The private sector agendas and advancements will also influence system operations and maintenance, and inclusion and collaboration with the private sector will be an integral component of future SMO.

The overarching theme of the vision is **Active Systems Management and Operations**. There is commitment to proactively managing all components of the vision through processes, tools, performance measurement and partnerships that will help achieve the desired SMO vision for the region.

Inherent in 'Active Systems Management and Operations' are:

- Robust traffic management systems that are operated by public sector agencies in response to real-time traffic conditions;
- Seamless capabilities and information across systems, modes and jurisdictions;
- Critical information pushed by public agencies to travelers and devices;
- Recognition that travelers can and will be 'connected' to the system in multiple ways and through multiple channels;
- An understanding of the required staff, system, operations and maintenance resources to support the desired level of integrated corridor operations, and ultimately level of service, to be provided to travelers;
- Flexibility to adapt to and integrate rapidly emerging technologies that will influence system management and operations;
- Integrating real-time performance outcomes into real-time operations; and
- Enabling policies that support active systems management and operations.

2.1 Future Concept of Operations

This section describes the future concept of operations for the MAG region in 2030. The concept describes how the regional transportation system will operate in this vision state by considering the key components of the future vision and concept.

Multimodal Network

The future transportation network *infrastructure* includes a set of **management systems, modes and corridors** that support regional mobility and connectivity. Facilities such as freeways, arterials, and key transit routes, as well as the various systems that allow them to be managed, are part of this network and collectively move people and goods throughout the MAG region. **Integrated corridor management** (ICM) is the primary operational strategy used to address recurring and non-recurring congestion on freeways and adjacent arterials. An ICM is supported by a **decision support system (DSS)** that facilitates **interoperability** between different agency central management systems.

An Integrated transportation network among *system operators* creates synergies between different facilities and between *vehicles* that use **multiple modes**. The integration of facilities and systems provides many benefits,

including **balancing priorities** between modes and facilities within the network based on real-time conditions and user demand.

System users benefit from the **safe, reliable and seamless** transportation network. System users interact with and influence the network though their travel decisions, use of information, and devices that provide data and information to system operators and other service providers.

Partnerships

There are **strong partnerships** among agencies in the region that enable **operations coordination** for network management. Innovative institutional structures allow for **24/7 system management and operations** on facilities within and across jurisdictional boundaries. One key partnership is between state and local emergency responders and law enforcement, who are key players in the success of ICM during traffic incidents and other special events that impact the transportation network. The future concept fully integrates local responders, traffic management and law enforcement into coordinated traffic incident management responses. Collaboration is made possible by establishing agreed-upon goals and processes to manage events that impact operations on corridors, well defined roles and responsibilities, and necessary resources to sustain desired levels of coordination. Partnerships and agreements also play a critical role towards addressing the region's **commitment to maintenance** system health, and interoperability.

Data

Data to support information on current travel conditions, available travel options, and short-term predictions on travel conditions is available across all modes. There are multiple sources of real-time data, including data from agency systems, vehicles, and mobile devices. The freeways, arterials and transit routes are well equipped with infrastructure and supporting systems that allow for robust, **real-time** data collection (from vehicles, and travelers) and **performance monitoring** of the network to **inform operational decision making.** A regional **data hub** collects, processes, shares and archives transportation data and from all agencies who operate transportation systems in the region. There are policies and systems in place to provide a level of **data security** that makes sure that all systems, users and information is secured.

Systems Management

The data hub feeds regional **decision support systems** that support 24/7 transportation operations in the region to manage both recurring and non-recurring congestion. Information from support systems is used not only for operations by multiple agencies in the region but also expands data feeds to new tools that provide **traveler information**. Information is pushed to travelers across a wide range of tools to help them make **informed decisions** about their travel, including route, departure time and mode choice.

In addition to real-time performance monitoring, the region has a commitment to strong **performance management** to help track the performance and progress of the network over time. Performance management also informs real-time operations. This performance reporting goes beyond the MAP-21 reporting requirements and is used to inform regional priorities and investment decisions.

Technology

By 2030, **connected and autonomous vehicles,** and other **emerging transportation technologies,** have strong influences on transportation system operations. MAG partners are prepared for these advancements and have the infrastructure, policies, and processes in place to accommodate the impact of these changes on the transportation network and incorporate new data within agency systems. Connected vehicle technology supports improved traveler information dissemination by allowing agencies to push information to vehicles in real-time. It also has the potential to provide agencies with a more ubiquitous set of data on the transportation network. The technology

supports the improved balance of modes within the transportation network, especially related to signal prioritization.

There is a plan for how the region will continue to address emerging and **transitioning technologies.** The region continues to stay informed of technology advancements and has **funding and procurement mechanisms** in place to procure equipment and systems that are needed to keep up with advanced transportation technologies.

People Behind Advanced Technology

It would not be possible to take advantage of many of the anticipated technology advances without having highly-skilled staff at the public agencies that are expected to utilize these technologies. One strategy to address this human resource challenge are partnerships with the local universities to provide a steady supply of highly-trained staff with the skill sets that are essential for managing and operating the transportation system. A central piece of this collaboration with the Arizona State University (ASU) is the establishment of a virtual Traffic Management System, also linked to the Decision Theater at ASU.

3 CONTRIBUTING FACTORS TO THE 2030 VISION

In addition to stakeholder and expert input into the vision, there are several assumptions that contributed to the vision. These factors fall into the following three categories: future infrastructure, realistic technology evolutions, and likely trends in travel behavior. These are described in greater detail in the subsections below.

3.1 Planned Projects and Infrastructure Enhancements

There are several infrastructure improvements and new road construction projects identified in current MAG plans, including the RTP and Prop 400 planned projects. Numerous initiatives, restructuring and reprioritizing of planned projects will shape the region's transportation system over the next decade, including:

- Completion of the South Mountain Freeway (Loop 202), SR-303 (I-10 to SR-30), SR-30 (I-10 to SR30), and SR-24;
- Implementation of a wrong-way detection pilot deployment on the I-17, the I-10/I-17 Spine Near-Term Improvements (and potential mid-term enhancements);
- Advanced ramp meter operations for the urban freeway management system;
- Continued testing and evaluation of adaptive traffic signal control systems for key arterials;
- Loop 101 widening, US 60 additional lanes, and construction of new HOV lanes; and
- Several transit service expansions and light rail expansions, including those planned as part of the Transportation 2050 Plan and tax revenue.

MAG has completed the rebalancing of funding in the Regional Freeway and Highway Program. With the Loop 202/South Mountain Freeway accelerated in the work program, this may offer some opportunities to move several other projects forward and sequence them in such a way as to minimize impacts to travelers and take advantage of economies of scale by potential combining projects. Recommendations have been developed and are currently being reviewed at key MAG committees (Transportation Review Committee, Transportation Policy Committee and Regional Council). This rebalancing could help projects be implemented sooner to address growing priorities (including current growth, increasing traffic volumes and safety issues).

The City of Phoenix passed proposition 104 which has resulted in a robust multimodal Transportation 2050 Plan. This plan will target funds toward street maintenance, sidewalk enhancements, traffic signal enhancements, Bicycle Master Plan recommendations implementation, and light rail and transit services expansion.

3.2 Technology Evolution

Technology is a critical component of the region's current system management and operations capabilities, and will remain a cornerstone of the region's overall SMO strategy. There are challenges in keeping pace in a dynamic technology environment, where there is innovation as well as uncertainty as to how new technologies can be integrated and adopted.

- By 2030, it is estimated that the industry will go through at least two technology generations or cycles. In prior years, technology infrastructure had a longer life span (i.e., freeway dynamic message signs would have an expectancy of 15 years). Today's mobile and communications capabilities are increasing functionality but shortening technology generations.
- It is anticipated that there will be multiple legacy systems throughout the region. It might not be practical or feasible to implement regionwide updates to all equipment. It will be important to identify interface and interoperability needs, and begin thinking about what kinds of systems will be critical to update. There might also be opportunities to seek private partnership or contracted capabilities for certain systems.
- Smart City concepts will be deployed and likely evolving and expanding their reach throughout the country. The Smart Cities Initiative focuses on innovative research, technology and connecting critical services to improve mobility, reduce environmental impacts of transportation, and make city and public services more accessible to residents, particularly to underserved communities. The Federal Highway Administration is one of several national agencies supporting the Smart Cities Initiative.

Over the next decade, Connected and Autonomous Vehicles (CV/AV) are expected to be more prevalent on the transportation network. Development and testing of CV/AV is already happening in the region. The Arizona Connected Vehicle Test Bed in Anthem is testing vehicle-to-vehicle and vehicle-to-infrastructure communications. Google is testing autonomous vehicles in Chandler, and will be expanding to other parts of the Valley, including Phoenix, Tempe and Mesa. Google is also building a training and maintenance facility in Chandler, which indicates the company plans to continue investing in AV technology in the region. This will be a transformative change to how travelers use the network, and one that does not have a precedence in other urban areas. There is an Executive Order (2015-09) from Arizona Governor Ducey that states that ADOT and other State Agencies will test, pilot and support operations of self-driving cars in Arizona. The Executive Order also establishes a Self-Driving Vehicle Oversight Committee.

3.3 Influences of Social and Travel Behavior

There are several other trends that are expected to influence how agencies will need to consider system management and operations in the future.

- "Mobility as a service," where there is a shift away from personally owned transportation in favor of creating markets for providing mobility and connections to mode options. Rideshare services such as Uber and Lyft are gaining popularity as an alternative to vehicle ownership.
- The influence of private sector applications is already shaping transportation programs. In addition to private sector data being used in place of traditional agency-owned infrastructure, crowdsourced applications (such as Waze) are allowing users to directly contribute incident, event and delay information. However, the solid links between driver distraction and elevated crash risk may prohibit public agency involvement in such applications.
- Social networking tools, including Facebook and Twitter, are being used by nearly every agency in the region to connect with travelers by sending alerts, promoting programs, providing public service announcements, and conducting education/outreach. These tools provide instantaneous communication, and contribute to traveler expectations of always being connected, and always being informed. Web sites that require a user to

seek information are being replaced with proactive 'push' notifications that send pertinent information directly to travelers.

4 CHALLENGES AND SOLUTIONS TO ACHIEVING THE 2030 VISION

The MAG Region builds on a solid foundation for SMO. Even with this foundation, achieving several elements of the 2030 SMO Vision will require some significant shifts in operational relationships, operations processes, roles and responsibilities. This section identifies key challenges and potential solutions at a high level; specific solutions and strategies will be captured in later tasks in the SMO Plan.

4.1 New Business Models

Challenge: The current business models and institutional structures for SMO are not likely to support the 2030 vision for operations and maintenance. The current model is siloed, with each agency operating and maintaining its own infrastructure and systems. Except for one agency, there is no capability at local agencies to support after-hours operations during emergencies. As a direct result of the initial Concept of Operations developed for the I-10 ICM, discussions have begun between local agencies, City of Phoenix, Maricopa County and ADOT to identify potential solutions to after-hours coverage for the I-10 corridor. The same challenges exist in relation to maintenance. The increase in technology applications and desired capabilities in the 2030 vision will come with a simultaneous increase in maintenance responsibilities that agencies may not be able to fulfill.

Possible Solutions: Alternative institutional arrangements should be explored for SMO in the region. One such model is consolidating operations through a regional or sub-regional operations support structure. Partnerships for operating systems after-hours, whether through a regional, or sub-regional TMC or through a model such as an on-call schedule with remote operations capabilities. These would help provide the desired level of coverage and faster response to network issues required and will encourage the sharing of resources and increased efficiencies for the use of staff time.

Partnerships or contracted options for device maintenance also can be established, where one agency or a regional partner may help maintain devices or systems for other agencies. This sort of partnership has historically been used by agencies in the MAG region related to traffic signals, DMS and traffic signal systems and helps take advantage of regional resources and economies of scale. There are numerous examples around the country of contracted maintenance for system devices.

4.2 Staff Knowledge and Skills

Challenge: Implementing and operating the network with technologies and systems for future concepts, such as ICM or connected and autonomous vehicles, will require staff training and development of new skill sets and operational and maintenance processes. This type of learning will take time and effort to obtain. At the same time, agencies will likely experience loss of institutional knowledge and experience due to staff turnover and retirement, thus requiring further training of newer staff.

There will also be additional skills and expertise required to manage and use the large amounts of data that are generated by emerging technologies. Staff will be needed for data monitoring, processing and analysis, and without staff with the proper skill sets, training and experience, the vitality of the systems and processes in the 2030 vision will be diminished.

The lack of a substantial link to the academic and research community in Arizona is a key missing link for successful deployment of advanced transportation technology solutions. Local universities have experienced faculty who are well recognized nationwide for their research work related to SM&O.

Potential Solutions: The traffic engineering laboratory at ASU, currently linked to the MAG Regional Community Network via fiber communications, could serve as an excellent training facility. The USDOT recently selected ASU as a University Transportation Center. A closer collaboration between ADOT, MAG and ASU could help address the staffing and skills challenges of the future.

Another solution for addressing gaps in staffing knowledge and skills is to leverage existing partnerships among agencies in the region to share knowledge, skills and resources that may be needed. Agencies can also partner with the private sector to either provide technical training to agency staff or provide the skills and expertise needed through contracted work.

In addition to partnerships, MAG can assist in addressing challenges with knowledge and skills gaps by providing relevant training that is available region-wide, such as the annual SYNCHRO training that MAG currently provides. A similar model can be used to provide training related to emerging technologies, systems and processes in the 2030 vision. The first step for this solution is to make sure there is an understanding of types of training that agency staff will need for future operations. It may be the responsibility of MAG to stay informed of technology innovation and the types of training and information that the region will need.

4.3 Infrastructure and Systems

Challenge: The speed of technology innovation and technology lifecycles is already creating challenges for agencies who find their infrastructure to be out of date, incompatible with newer systems or no longer supported by vendors. As the speed of technology innovation increases and a whole set of new technologies related to connected and autonomous vehicles and other emerging technologies are released, agencies could find that they cannot keep up with the pace of innovation.

Further, the frequent technology turnover will also create compatibility challenges for agencies. Even today, agencies noted compatibility issues when undertaking central management systems upgrades, where older equipment and newer software were no longer compatible. In addition to internal agency incompatibilities, there may be challenges related to intra-agency compatibility (i.e. interoperability) if there are many different vendors for devices and systems that accomplish the same task but are not developed to be compatible.

Potential Solutions: A possible solution to combat equipment compatibility issues is to set regional standards or specifications for equipment and systems, like the goal of emergency vehicle preemption (EVP) study done by MAG. This process can provide informed guidance for device and system procurement based on the most up-to-date information, and it can help support regional interoperability of devices and systems.

A supplemental strategy to support device standardization and support technology procurement in general is to consider a model where some infrastructure and systems are procured by one local agency, based on a standard adopted by the region, and made available to all agencies in the region. One example of this kind of model is the Luxriot system, where a regional license has been procured by MAG and has been made available to all agencies for no cost. However, MAG would not be able to procure larger systems on a regional basis.

4.4 Data Processing and Storage

Challenges: In addition to challenges related to data management skills and expertise, there are potential physical challenges related to data collection and storage. Agencies will need to have systems and equipment that can handle much more data than is currently available and used. The Regional Archived Data System (RADS) currently serves as a multi-agency data center, and was recently updated to provide greater data processing and storage capabilities related to connected vehicles and other advanced transportation technologies. Future data processing and storage needs will need to be defined, and systems will need to continue to be expanded to accommodate the data demands of the 2030 vision.

The gathering and archiving of data need to be better focused and driven by useful applications. At present there is no regional oversight process for RADS developments to ensure that its uses serve regional goals.

Potential Solutions: One likely solution to this challenge, which is already being investigated in the region, is using cloud-based data storage solutions. This option could present its own challenges related to data security, IT policies, and associated costs, which also should be addressed to reach the 2030 vision. Establish a regional oversight process to guide the future role of RADS and how it may serve as a reliable source of data. Institutional arrangements for data acquisition, management and analysis will need to be expanded. This is another opportunity to partner with ASU and have them assist in data management, data analysis and performance reporting. There are also many examples of these types of partnerships, such as the Maryland Center for Advanced Transportation Technology (CATT), which was developed as a partnership with the University of Maryland and is integrally involved in projects for the Maryland State Highway Administration, Federal Highway Administration, and the I-95 Corridor Coalition. Across the United States, many successful transportation technology deployments over the last 20 years have involved close collaboration between transportation agencies and one or more local universities. For the MAG region, it is essential that a research alliance be formed with Arizona State University (ASU), the University of Arizona (UA) and other universities. ASU was recently selected by the USDOT as a Tier 1 University Transportation Center (UTC). This will expand on the current research and project relationships between transportation agencies and Arizona universities.

5 TRANSITION STRATEGY

The 2030 vision builds on strong foundations in the MAG region. There is a long history of collaboration, innovation and technical leadership among agencies. The 2030 vision emphasizes a key priority – the traveler – as a central component that guides the priorities for technology enhancements, data, and an integrated network.

Reaching the 2030 vision will be an incremental process. There will likely be some key transition timeframes that align with regional milestones (such as the next Regional Transportation Plan and Proposition 400 sunset) and national milestones (such as final ruling on MAP-21 mobility performance reporting, additional policy and/or regulatory requirements emerging from federal agencies). Technology milestones are more challenging to predict, such as when CV/AV will be reaching a critical mass on the network, the "Internet of Things" and how that might influence traveler behavior and agency priorities, or even the next big generation enhancement of Wi-Fi.

It can be challenging to envision a transportation operations and management strategy in the MAG region that does not include in-pavement detection for data, dynamic message signs, closed-circuit cameras or even traffic operations and management centers. Technology is, and will, enable many functions that have traditionally been accomplished through agency-owned field equipment, centers and systems. Data, communications, mobile computing, and information storage are changing at the pace of technology innovation.

5.1 Near-Term Transition Needs

There are several plans that are recommended to guide transition and coordination, and provide key input to the next Regional Transportation Plan. The need for these plans will be addressed in more detail as the SMO Plan evolves:

- Regional ICM Plan, including desired corridor functionality, operational processes, roles, responsibilities, and gaps to be addressed. This will help guide ICM implementation on a larger scale throughout the region, and can leverage the lessons learned from Loop 101 in Scottsdale, the I-10 ICM effort and outcomes from the I-10/I-17 Spine Corridor.
- Data Management Plan, which will include data needs, storage and access requirements, identify data gaps and specific timeframes for when and how data gaps will be addressed. This could include a regional data procurement strategy to get real-time data beyond what agencies are currently obtaining today, as well as identifying potential needs for expanding current data storage and sharing capabilities.
- CV/AV Plan and Policy, which can leverage the USDOT guidance and Arizona's Self-Driving Vehicle Oversight Committee. This CV/AV Plan should emphasize key corridors or cities/towns that are strong candidates for more widespread implementation. The MCDOT SMARTDrive Program Test Bed in Anthem provides some important lessons learned related to connected vehicle traffic signal applications and technology implementations.

5.2 Operations Transition Needs

From an operational standpoint, transition considerations will need to look at equipment lifecycles and replacement, strategies for maintaining equipment, as well as increased collaborative operations.

- Support agencies with strategies and tools for lifecycle costing for equipment used for SMO. For the next several years, it is anticipated that agencies will continue to operate and maintain equipment such as traffic signals, cameras, communication infrastructure and dynamic message signs. With the stated need to support increased interoperability and compatibility among agencies, there is an opportunity to promote preferred equipment and standards for future equipment replacements. Lifecycle costing also will be able to inform equipment needs on an annual basis, and help MAG and partner agencies better plan for replacement.

- Expand initial pilots for shared operations, document lessons learned, and prepare a regional strategy. Initial agreements for shared operations among Maricopa County, Arizona DOT and the City of Phoenix will help to demonstrate how after-hours support for pre-agreed traffic signal timing plans can work. This can help lead to broader adoption of shared operations and potentially consolidate after-hours support.
- Develop Standard Operating Procedures (SOPs) to facilitate consistent operations, and for after-hours operations activities that are carried out by other agencies.
- Expand the AZTech Traffic Incident Management Coalition to specifically engage local law enforcement agencies. There has been strong leadership from state law enforcement, as well as from local fire and emergency services response and transportation. Local law enforcement participation has not been consistent across agencies, and they are a key partner for any incident (including freeway incidents) that impacts or closes arterials. Involving local partners will help to ensure that notification processes are updated appropriately.